DUST AND ITS DANGERS

PRUDDEN

FORM 113c, W. D., S. G. O.
(Revised June 13, 1936)

3—10543

GPO 16—71341-1

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BY

T. MITCHELL PRUDDEN, M.D.

AUTHOR OF "A MANUAL OF PRACTICAL NORMAL HISTOLOGY," "THE STORY OF THE BACTERIA," ETC.

G. P. PUTNAM'S SONS

NEW YORK
27 West Twenty-third Street

LONDON
24 Bedford Street, Strand

The Knickerbocker Press

1894

The Knickerbocker Press, New York
Electrotyped, Printed, and Bound by
G. P. Putnam's Sons

PREFACE.

THIS little book has been written with the purpose of informing people, in simple language, what the real danger is of acquiring serious disease—especially consumption—by means of dust-laden air, and how this danger may be avoided.

It is an unpleasant subject; but it is one which every one must know something about if he would avoid such physical ills as are much more serious drawbacks to comfortable living than are the temporary mental disquietudes which this book is designed to inflict upon its readers.

T. M. P.

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ILLUSTRATIONS.

DUST AND ITS DANGERS.

CHAPTER I.

THE NATURE OF DUST IN GENERAL.

IF this were not a practical age, and if the title on the back of this little book did not fairly promise a reasonably practical theme, it might be thought incumbent on the writer, in this age of nice analysis of very small things, to be explicit at the outset as to what he does or does not mean when he says dust. For after all, when we think of it, there are a good many kinds of dust. There is, for example, molecular dust, which swaying ever in space catches and breaks the sunbeams, giving us now the deep blue of full day and again the gorgeous colors of the earlier and later hours.

There are those masses of "water dust" which we call clouds and fogs and steam. There is the scriptural dust, bearing, according to orthodox traditions, such a close relationship to the origin and endings of mundane existence. Colloquially, there is a form of "dust" too which to win many a mortal seems to forget both his origin and his destiny, yielding at last that dust which he has won to be himself resolved into that to which he was foreordained.

But if we plant our standard on Webster's first choice, and let dust be for us "Fine dry particles of earth or other matter so attenuated that it may be raised and wafted by the wind," we shall not be apt to stray too far from the practical, nor fall foul of either primordial or ecclesiastical or pecuniary dust.

Simple, common, omnipresent every-day dust then,—the bane of the tidy housekeeper, the torment of the cleanly citizen who goes upon the streets in ill-kept towns, wafted upon every breeze without, stirred by every footfall within, —this is the humble but significant subject to which, not without reason, it is believed, these pages are devoted.

The dust particles of the air may be roughly grouped in two classes—first, those larger bodies which are readily visible in-doors or out-doors, and second, the smaller particles which are usually only seen when strongly illuminated.

The coarser particles of dust, such as are usually swept into our faces whenever we go upon the streets in New York in dry and windy weather, consist largely of small fragments of sand, broken fibres of plants, pollen, fine hairs, the pulverized excreta of various domestic animals, ashes, fibres of clothing and other fabrics, particles of lime or plaster or soot, parts of seeds of plants, masses and clusters of various kinds of micro-organisms, and other partially ground up materials of kinds too numerous to mention.

The finer dust particles, whose presence, when in considerable quantities, we may be aware of by the choking sensation which they cause when breathed in, even though we do not see them, are most plainly visible as the so-called "motes in the sunbeam," when sunlight streams into more or less darkened places. These are very light and consist of fragments

of fine vegetable or animal fibres, such as cotton or woollen or other light material, and of the greatest variety of micro-organisms, either singly or in masses, such as bacteria and mould spores. Furthermore, these micro-organisms are very apt to be found clinging singly or in clusters to the larger or smaller inorganic particles of one kind or another which usually make up the bulk of visible or invisible dust in inhabited regions.

It is not necessary for our purposes here to enter in detail into those conditions of soil and climate and human occupation which favor the presence of dust in the air. That dry air and dry-ground surfaces and winds favor the distribution of the fine particles which we call dust, and that still air and moist ground tend to hold it in check, are facts which every one's observation teaches.

It is well known that there are certain occupations which confine persons to closed rooms or places in which dust particles of one kind or another are very abundant. Thus day after day persons confined in air charged with coal-dust or stone-dust or metallic-dust or cotton-

or woollen-dust or tobacco-dust, etc., are apt to become victims of more or less well marked pulmonary affections, which are to be found fully described in systematic treatises among the so-called "diseases of occupation."

It is not with these exceptional places nor with the special conditions which belong to them that we are now concerned, but with the conditions under which both well and sick people of all classes are placed, especially in cities, and more particularly when in-doors. Nor shall we occupy ourselves here to any considerable extent with the inorganic ingredients of dust, but more especially with those living components called micro-organisms, be they either bacteria or moulds.

I purpose, in the first place, drawing upon the results of various old and recent studies, to indicate the sources of the living germs which form such an important part of the dust of inhabited regions, the ways in which they get disseminated in the air, and their general deportment as they are driven hither and thither by the winds, sway poised in the still air of quiet places, or settle slowly to the ground.

I purpose then to show the difference of conditions which prevail, in-doors and out, and the significance of these conditions in the problems of ventilation and cleanliness. I shall then give the results of a series of studies of the atmospheric micro-organisms in various places, and consider the relationship of these aërial germs to some common forms of disease. Finally, I shall suggest some of the measures which must be adopted, both by the public authorities and private persons, if both out-of-doors and in-doors we are to have the privilege of breathing clean and wholesome air. I shall not, except incidentally, touch upon the ordinary problems of ventilation or the numerous ways in which by the accumulation of the products of respiration and exhalation the air of inhabited rooms may become an active source of discomfort and ill-health, because the means by which these evils may be avoided are well known and are fully explained under the heading of ventilation in text-books and treatises on hygiene.

CHAPTER II.

THE LIVING ELEMENTS OF DUST; WHAT THEY ARE AND WHERE THEY COME FROM.

ALL those forms of minute vegetable life which swarm in myriads almost everywhere upon the earth's surface are called in general *micro-organisms* or *germs*. Among these there are three prominent forms which are called *bacteria*, *yeasts*, and *moulds* (see Plate I.). Among these the bacteria are by far the most important. These tiny organisms are for the most part so very small that many thousands or millions of them clustered closely together would not make a mass larger than the head of a pin. Some of them are round or ovoidal, some rod-like, some spiral (see Plate I. Fig. 3). Most of them are harmless to man, and serve a very important purpose in the economy of nature in tearing asunder

dead and worn-out organic material and setting it free in suitable condition for the building up of new forms of life. A few species of bacteria, however, are capable of causing some of the most wide-spread and most dreaded of human diseases.

The writer has in another book[1] described in simple and untechnical manner the various forms of bacteria and their relationship to man, and to this he must refer the reader for further details as to their nature and life history.

The moist surfaces of decaying vegetables and plants and the bodies of animals, all solid excreta of the bodies of men and animals, human sputum, stagnant water, the surface of the soil in inhabited regions, etc., afford fertile fields of growth for myriads of micro-organisms of one kind or another.

But we should always remember that bacteria do not become detached from the surfaces or materials on which they grow or are lodged while these are in the moist condition. Even the air sweeping in strong currents through sewers whose watery contents and moist walls

[1] "The Story of the Bacteria."

Fig. 1.

Fig. 2.

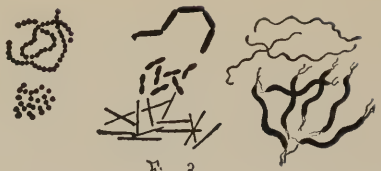

Fig. 3.

FIG. 1.—A small portion of the common *green mould* (Penicillium) sending up into the air little stalks at the ends of which are strings of easily detached very light spores.—Highly magnified.

FIG. 2.—*Yeasts:* growing by sending out buds. These are the plants which as they grow in sugary solutions break up the molecules of the sugar, setting free alcohol and carbonic acid; hence their importance in beer-making and in other fermentative processes.—Highly magnified.

FIG. 3.—*Bacteria.* Showing the little plants of various shapes and sizes, but all formed on one of three types—balls, rods, or spirals.—Highly magnified.

PLATE I.—DIFFERENT FORMS OF MICRO-ORGANISMS.

may be swarming with bacteria does not become charged with these. The bacteria, singly or in masses, free, or attached to other particles of one kind or another, must first be dried and then the clusters more or less pulverized or ground up, before they are swept away and suspended as a part of the dust in the air.

There are indeed certain moulds—the green mould, for example, which is so common on various moist articles of food—which form very light and not easily moistened spores (see Plate I. Fig. 1), these may be readily brushed or blown off and mingle with the dust under almost all conditions.

All sorts of bacteria-laden material then, when dry and ground up as it so readily is by the varied movements of men and animals out-doors and in-doors, may become a part of the floating dust. These dry minute germs, some of which are alive and some dead, comport themselves in the air just as lifeless dust particles of any other kind do. They are wholly inert, and are driven hither and thither by air currents, now in clouds or masses of al-

most stifling density, and again in very small numbers, collecting in whirls and eddies, and finally, always sooner or later, settling down to the lowest available resting-place, as soon as the buoyancy of air currents gives way to the ever acting attraction of gravitation. Since the bacteria of dust are very apt to be in little groups or clusters or to cling to other dust particles, most of them readily settle, so that a very considerable part, in fact, of the finer dust—the "motes in the sunbeam"—is not made up of bacteria or germs but of other forms of lifeless matter.

CHAPTER III.

HOW THE LIVING ELEMENTS OF DUST ARE STUDIED.

HOW do we find out how many living germs there are and of what kinds in a given volume of air? It will suffice for our purposes here to say that the bacteria are so extremely small that the search for them as they occur in nature is ordinarily of little avail by the simple use of the microscope.

We have recourse in such studies to what is called the "culture method."[1] By this method, instead of bringing a portion of fluid or of the air in which we wish to seek for bacteria directly under the microscope, we mix a small portion of the fluid or air with some material which serves as food for the germs, and on or in which they will readily grow.

[1] See "The Story of the Bacteria."

This food medium usually contains some form of gelatine. The gelatinized material is usually melted when the planting is being done, and when it cools the bacteria are held firmly in the position in which they lodged when they were put in.

The bacteria placed under these conditions multiply with such great rapidity that usually in a short time the progeny of a single living germ will have accumulated to such a degree right in the spot where the germ lodged that the mass of them, which we call a "colony" will be readily visible to the naked eye, or under a low power of the microscope (see Fig. 1). Now since we can readily see the mass of bacteria which has grown where only a single germ had lodged we have only to count the colonies to know how many living bacteria were present in the volume of air or fluid which we have tested.

We can now, futhermore, subject the little colonies which form our bacterial crop to a variety of examinations and tests, and make out what kinds there are, and further learn their effects upon man or animals.

Now a good many plans have been devised for finding out how many living germs are present in a given volume of dusty air. We

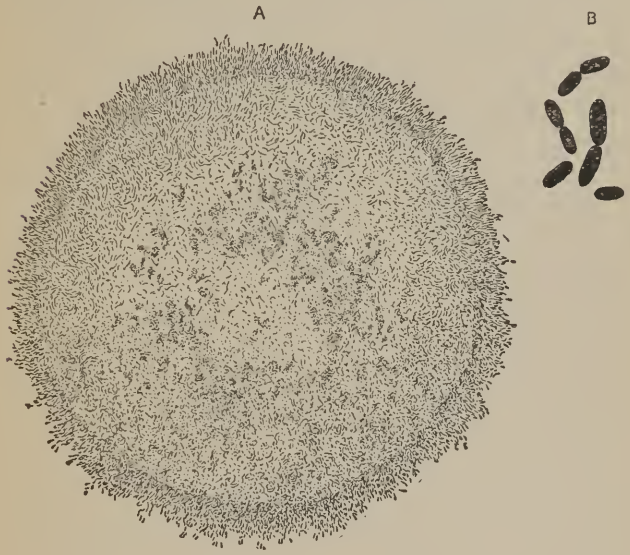

FIG. 1.

Fig. 1. A—A single "colony" of rod-shaped bacteria (Bacilli) growing on a plate of nutrient gelatine. The actual diameter of this colony was about one-fourth of an inch. B—A cluster of the bacilli taken from the colony and highly magnified.

may force a given volume of the air through a tube which has been plugged with cotton-batting previously heated so hot as to kill any

germs which by chance have been upon it. The cotton if properly packed in the tube will catch and hold entangled in its meshes all the dust particles no matter how small, and with these all the bacteria which were in the air which we force through the tube. If now we carefully pull out the cotton plug with a pair of perfectly clean forceps, and thoroughly rinse it off in a small clean flat dish containing our bacterial food—which we call "the culture medium,"—the germs will be distributed through the medium, and we cover the dish and set it aside in a warm place and let it stand until each living germ has grown and multiplied till it forms a visible colony. Now we count the colonies, and the number represents the number of living germs which were present in the whole volume of air which we forced through the cotton plug. There are of course many details and precautions against error which must be observed, but this brief description will suffice for our purposes here.

It has been found in practice, however, that it is better to use fine sand than cotton in the tubes to catch the germs, since this is more

easily handled and is equally efficient as a filter. We plant the sand together with the dust which it has caught in the melted culture-medium, allow it to cool and then stand for a few days, and when the colonies are grown they are easily distinguished from the sand particles by their shape, color, etc., and can be readily counted. Or, we may use granulated sugar for a filter, which finally dissolves in the culture-medium, leaving the bacteria to grow in due time. This may be called the "filtration method" of air analysis.

As it requires an accurate and somewhat complex and cumbersome apparatus to force or draw the air through either the cotton or sand filter, another and simpler method is often resorted to, which, though in some respects less accurate, still gives very useful results when we wish simply to compare the germ ingredients of the air in one place with those in another under similar general conditions.

This simpler method consists in pouring into a series of perfectly clean shallow glass dishes a thin layer of the warm gelatinous culture-

medium and allowing it to solidify by cooling. This gives a smooth, moist, somewhat adhesive surface of equal size in each of the dishes, which are immediately protected from any chance contamination by closely-fitting glass covers.

This mode of air analysis depends upon the fact which we have mentioned above, and which everybody is familiar with, namely, that all dust particles, light or heavy, in quiet places, slowly but surely settle towards the ground. If now we set one of our covered dishes in a still place and take off the cover, the dust particles, the inorganic as well as the living, will settle on to this moist nutrient surface. With the inorganic components of the dust, the multifarious shreds and patches of one thing or another, this is the end of the matter. But as the living dust particles touch the surface, like Antæus, they find their abeyant vigor quickly renewed, and forthwith commence to multiply and inherit their little new-found earth. Now, suppose we leave our dishes uncovered and exposed to the falling dust for, say five minutes ; suppose further that the sur-

face of the culture-medium is three square inches in size, it will be readily seen that by the exposure of dishes of the same size for the

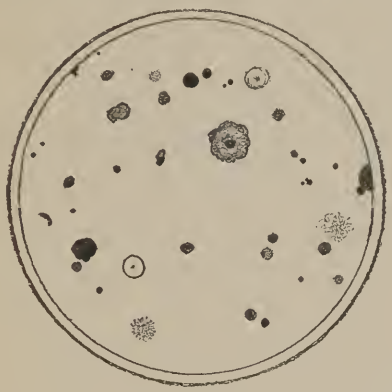

FIG. 2.—THE "PLATE METHOD" OF AIR ANALYSIS.

The cut shows the appearance of the flat, shallow dish, the bottom of which was covered with nutrient gelatin, and when this had cooled and solidified, was uncovered and exposed to the air in a moderately clean place for five minutes. It was then allowed to stand in a warm place for four days. Immediately after the exposure of the gelatin to the air nothing whatsoever was visible on its surface. But within a few hours tiny spots appeared which grew larger, some more rapidly than others. These "colonies," at the end of four days, when the drawing was made, vary considerably in size and appearance, because they are mostly made up of different species of germs. Each colony consists of thousands of germs (see Fig. 1, A), which have grown on the spot where the lone ancestor fell from the air and stuck fast during the five minutes exposure of the gelatin.

same time to the air of different places, we can, by comparing the number of bacterial

colonies which develop on the surfaces, get at least an approximate idea of the relative number of suspended bacteria slowly settling in the air of the different places (see Fig. 2).

We cannot, of course, by this method say how many germs were present in a given volume of air, as we can by the more elaborate and accurate method given above, and there are many minor sources of error. For example, the mould spores are so very light and buoyant that they fall but slowly, so that we may altogether miss many of them, and the same may be true of some of the lighter bacteria. Moreover, even very slight upward air currents may interfere with the settling of the germs, and in windy places this method is of little use. But on the whole, if similar conditions are maintained in the different analyses, comparative results may be obtained in this way which are of much value, as we shall presently see.

This, which we will call the "plate-method," enables us to get a general notion of the bacterial contents of the air in various places under conditions which would render the use of the

more accurate and cumbersome apparatus difficult or impracticable. We can go about with our innocent-looking little case of glass boxes, partly filled with nutrient gelatin, as does the amateur photographer with his detective camera; though instead of "pulling the string, touching the button, and leaving the rest to the manufacturer," we raise the cover, take the time, and let Nature do the rest.

We are now ready to look at the results of a series of so-called biological analyses of the air of various places. We mean by biological analysis of air, in distinction from the chemical, an analysis which has for its object the determination of the number or character, or both, of the living germs, or micro-organisms which may be suspended in it.

CHAPTER IV.

THE MICRO-ORGANISMS OF OUT-OF-DOORS DUST.

WE must be on our guard in looking at the results of such analyses as those now to be described against hasty inferences as to their significance. It would be a grave mistake to suppose that living germs in the air are necessarily harmful to human beings, and to infer that air found to habitually contain few bacteria is necessarily more salubrious than that which contains more. For the present, then, let us look upon the results of these analyses simply from the biological standpoint, and, if possible, place ourselves in the attitude of botanists studying the flora of the atmosphere, not of physiologists concerned with the relationship of these tiny plants to man. This we shall come to by and by when we have accumulated enough facts to justify such inferences as may urge themselves upon us.

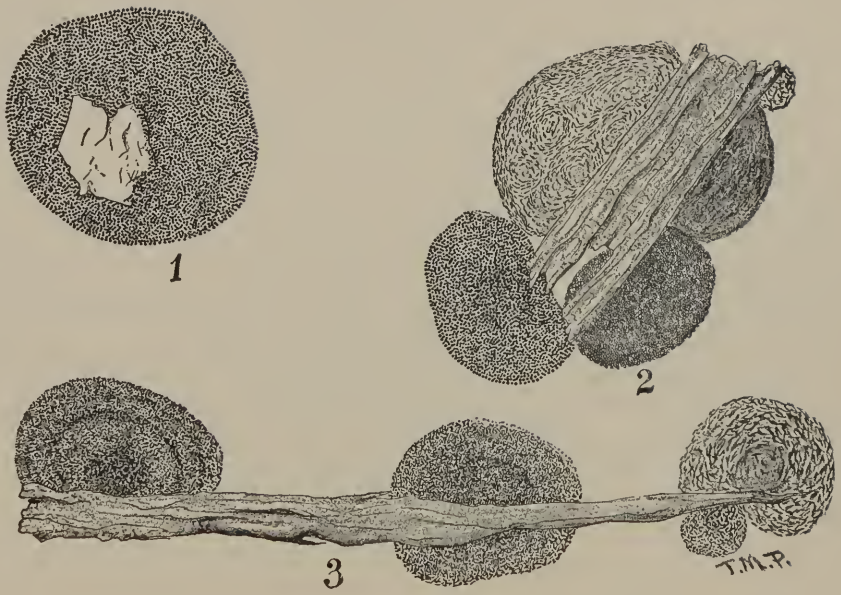

PLATE II.—COLONIES OF MICRO-ORGANISMS GROWING ON DUST PARTICLES.

EXPLANATION OF PLATE II.

This cut shows the appearances which are presented, after the germs have grown, by particles of sand and shreds of vegetable fibre to which single germs were clinging when they settled on to the uncovered gelatin plate. In this case the drawing was made five days after the exposure of the plate to the air of a dusty street. The largest of these colonies were barely visible to the naked eye.

1.—Shows a particle of sand completely surrounded by the colony or mass of bacteria which has grown from a single germ which was clinging to the minute sand particle as it settled with the dust.

2.—Shows a tiny shred of wood to which five different germs were attached as it settled on to the exposed plate. We should probably have searched in vain, even with a powerful microscope, for the single germs clinging to it at the time this wooden dust particle planted itself on the surface of the gelatin. But now the larger colonies are visible even to the naked eye. We know that they grew from different species of germs because under a moderate magnifying power they present such markedly different appearances.

3.—Shows a minute sliver to which four different forms of germs were clinging as it fell.

From the enormous number of bacteria and moulds, which are present everywhere in inhabited regions where the conditions are suitable for their growth, it might be imagined that in dry weather the number of atmospheric germs in the dust out-of-doors would be very great. But this is not usually the case, even in large and populous towns. Here and there along the streets, where these are filthy and almost never properly cleaned, as in New York, or where the wind whirls around the corners of buildings, forming air eddies, the micro-organisms are often present in very large numbers, so that one in passing about the town is apt here and there to encounter veritable germ-showers. But on the whole, almost everywhere out-of-doors, except in dangerously filthy cities, the large volumes of air, which are more or less constantly passing, so largely dilute the local germ-dusty air that the actual number of micro-organisms in a given volume, say a cubic foot, is on the average very small, and usually insignificant. When the ground is wet and air currents moderate, the number of germs is still further diminished.

It is very difficult to fix upon any definite number of living micro-organisms in the out-of-doors air which can be regarded as the usual or normal number, because the number varies so extremely under different conditions. Thus on high mountains or deserts and on the sea the unconfined air is practically free from micro-organisms. In the winter months, when snow is on the ground, during rain storms, and when the air is still, the number may be very small. On the other hand, a high wind blowing across a region rich in dry and pulverized germ-laden material, will for a time disseminate large numbers of micro-organisms; but at the same time it tends, by the dilution which it affords, and by carrying them off to other regions, to speedily reduce the numbers in any given place. A rainfall, to a certain extent, tends to free the air of its germs by washing them down, while during a snowstorm many are caught in the snow crystals as they form.

In wet weather mould-spores tend to predominate, partly because they then grow readily and partly because they are very light, and not as easily wetted and held down as are the bacteria.

The analysis of out-of-doors air shows, as might be expected, a great deal of variation in the number of living germs present in a given volume. Ten litres, which is about 600 cubic inches (that is a volume equal to a cube of about 8 inches square), is the volume of air usually taken as a sample for purposes of analysis.

Carnelly found in still out-of-doors air, in the town of Dundee, in Scotland, as the result of 14 analyses, an average of less than 10 bacteria in 10 litres of air, while in another place there were over 170 in the same volume.

Tucker found the air in Boston, from a secluded place, but in the immediate vicinity of its traffic, during the mild but rather windy weather in November, December, and January, with no snow on the ground, to contain on the average of 56 analyses, less than 20 bacteria to 10 litres. In an open court at the Hygienic Institute in Berlin, Petri found, as a rule, equally small numbers.

The average of 13 analyses, made in March and April, 1890, of the air from the yard of the College of Physicians and Surgeons, in New

York, at a place as far from the streets as possible, and about 25 feet from the ground, showed the number of bacteria in 10 litres to be 56 and of moulds 4.

Analyses, during the same period, of the air of the streets in New York, from various parts of the town,[1] showed the average number of bacteria in 10 litres to be 376, and of moulds 6. These analyses of street air were made under ordinary conditions, at such times of the day as the air appeared to be at its best.

If an analysis is made of the air in the dust clouds which sweep along the ill-kept streets of a city like New York or which blows from the street sweepers as they pass along the unwatered thoroughfares into the houses or over the unwary passer-by, the numbers of germs to the litre is startling.

Let us look at a graphic record of the relative number of bacteria in various places, made by the plate method already described.

Plate III. shows the result of a series of comparative analyses made in this way in var-

[1] This was at a time when the so-called politicians were juggling with the Street Cleaning Department while the streets were largely left to take care of themselves.

PLATE III.—SHOWING RESULTS OF "PLATE ANALYSES" OF THE AIR OF DIFFERENT PLACES IN NEW YORK.

(See explanation in the text.)

ious places in New York on a clear, dry, moderately breezy day, in April, 1890. Each one of the spots represents a colony of bacteria, which has grown from the single germ which settled on to the moist surface during the five minutes exposure to the air.

1. *Ball Ground, Central Park.*—A moderate westerly wind bringing dust over from the Eighth Avenue and its cross streets.

2. Union Square.—At the edge of the fountain basin.

3. The library of a private house not far from 34th Street and Broadway.

4. A large retail dry-goods store on one of the uptown cross streets near Broadway, during a busy hour of the day, when there was much stir and bustle.

5. Railing of the small park at Broadway and 35th Street.

6. A cross street through which the carts of the Street-Cleaning Department were passing collecting the dry heaps of street dirt.

If we translate into numbers the appearances of the cultures shown in Plate III., we find that during five minutes the number of living germs

which settled from the floating dust on to the bottom of a round dish about $3\frac{3}{4}$ inches in diameter in different places in New York was as follows:

1. Central Park.—Dust blowing from an adjacent street, 499.
2. Union Square, 214.
3. Private house, 34.
4. Large retail dry goods store, 199.
5. Broadway and 35th Street, 941.
6. Street in the process of being cleaned, by the Street-Cleaning Department, 5,810.

A sufficient explanation of the number of germs in the air at the lower part of Central Park is found in the westerly wind and the extremely filthy condition of the streets on the windward side. The result of the analysis shown in fig. 6, needs no lengthy comment. That as many living germs as of colonies which are here seen growing should be floating in the air and liable to be breathed in by any unfortunate passer-by within five minutes, is evidence enough of the filthiness of the present practices of so-called street-cleaning in New York. As to its danger, more by and by.

CHAPTER V.

THE MICRO-ORGANISMS OF IN-DOORS DUST.

WHEN we consider the comportment of dust particles in closed rooms, we see at once that the great renovating and cleansing agency which is so efficient out-of-doors is, except on special occasions, absent, namely, the winds and strong air currents and the more or less frequent and prolonged wettings. Once in a closed room dust is very apt, as every housekeeper knows, to stay there, unless special means are resorted to to get rid of it. But although the dust remains in the room, those heavier parts of it which contain most of the bacteria gradually sink to the lowest available levels, floors, shelves, furniture, etc., so that it has been found that the still air of a room may almost completely free itself from micro-organisms, except some of the lighter

mould spores, within one or two hours. Of course violent currents of air, walking about, etc., interfere with the very complete subsidence of the bacteria-laden dust particles.

Now it might be supposed that the frequent renewal of the air of a room by such a system of ventilation as would be effective in keeping its gaseous ingredients pure would also suffice to rapidly carry off dust particles, and bacteria as well. But a long series of most carefully conducted experiments by Stein has shown that this is not the case. Even when the introduction of fresh air is pushed to the complete renewal of the air three times an hour, the number of suspended micro-organisms floating in the air is scarcely more diminished than they would be by settling in still air. Stein found that only when the ventilation was carried to the degree of inducing marked and disagreeable draughts in the room was there a rapid diminution in the number of micro-organisms which had been diffused artificially through the air for the purposes of the test. Of course opening of the windows and allowing large bodies of air to blow through

the room, quickly resulted in sweeping away a large proportion of the suspended micro-organisms. But this observer also found that even very strong air currents were not able, when sweeping over woollen and other fabrics, carpets, hangings, etc., which had been bestrewn with bacteria-laden dust, to free the germs to any considerable extent from these. The strong air currents carried off the suspended particles, but those which had settled on to the fabrics and floors were but little affected. The practical bearings of this observation we shall see by and by.

When we consider the constant tendency of dust particles to settle as soon as they find themselves in quiet places out of strong air currents, and the fact that even ordinarily efficient systems of ventilation do not carry off any considerable proportion of the dust particles from closed still rooms, we are led to the rather startling conclusion that the ordinary living-rooms, even though they be well ventilated, are actually dust and bacteria repositories, and that when by a system of forced ventilation we cause large volumes of dust-

laden air from out-of-doors to pass through them we are actually, so far as micro-organisms are concerned, cleansing the air and sending it out much freer from germs than when it entered, these having slowly settled as the air made its way from the entrance to the exit of the ventilating openings. The same of course applies, though in a less striking way, to the so-called natural mode of ventilation—that is a ventilation system which has for its exit a warm air-shaft or chimney, and "trusts to luck" for channels of air entrance through loose joints in windows, doors, and walls.

Now, although in rooms through which for purposes of ventilation large volumes of dusty out-of-doors air are pumped, day and night, there will be in the aggregate a considerable accumulation of more or less bacteria-laden dust, it is, after all, the ground-up dirt which we bring in from the streets upon our shoes and garments, and the accumulations of waste material, which in dwelling-houses and places of assembly are so abundant, which furnish the larger proportion of the bacterial ingredients of in-doors air. The marked difference be-

tween the atmospheric dust in closed rooms and that out-of-doors is that in the former there is no spontaneous mode of purification of the air except that of settling, and that the settled more or less bacteria-laden dust is liable to frequent stirring-up by the ordinary movements of people, while out-of-doors the bacteria-laden air is constantly being swept off by the wind.

The effect of stirring about in rooms in which micro-organisms are present is shown by the analyses of Tucker in the wards of the Boston City Hospital. He found that about midnight after the wards had been quiet for a few hours, the number of living bacteria in 10 litres of air ranged from 0 to 13, while the number of mould spores ranged from 0 to 4. The air had practically freed itself from germs, by settling to floors and beds. He found that in a long series of hourly determinations in various wards at all hours of the day, the average number of bacteria in 10 litres of air was about 26 and of moulds about 12, the number of bacteria ranging from 1 to 477; of moulds from 0 to 227. The germs were more abundant in the air in

the forenoon when the beds were being made and the wards cleaned and put in order. He found that sweeping nearly doubled the number of germs in the air already disturbed by the routine work in the wards in the morning, and considering the number of germs in the 10 litres of air in the early morning before the wards were astir as the minimum—1—the general cleaning routine work and sweeping were capable of increasing the number, on the average, seventy times.

The difference in the number of living germs floating in the air of a room before and after sweeping, is graphically shown in Plate IV. The room in which these analyses were made, was a most carefully kept hospital ward in New York, in which were about 25 persons. Before the sweeping, when quiet had prevailed for about an hour, the number of living germs which settled on to the dish, $3\frac{3}{4}$ inches in diameter, was 12 (see Plate IV., Fig. 1). Immediately after sweeping, the number which settled on to a similar surface, was 226 (see Plate IV., Fig. 2). Very much larger differences are often found in the number of germs

Fig. 1.

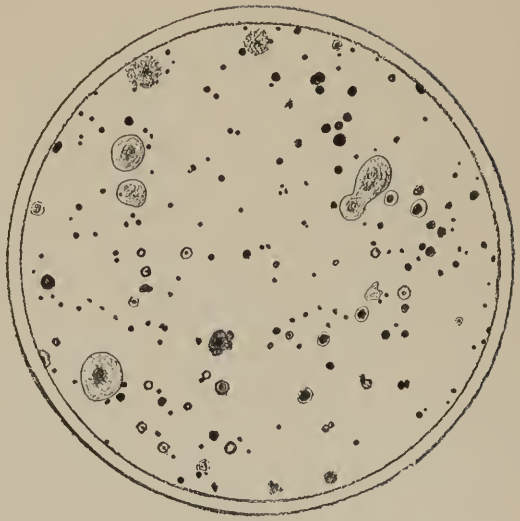

Fig. 2.

PLATE IV.—EFFECT OF SWEEPING ON THE NUMBER OF MICRO-ORGANISMS IN THE AIR.

FIG. 1.—Plate analysis of the air in a hospital ward before sweeping. Five minutes exposure.

FIG. 2.—Analysis of air in the same ward just after sweeping. Five minutes exposure.

in the air before and after sweeping, if the rooms are not frequently carefully and properly swept and dusted. Thus in a carpeted living-room in a tenement on 10th Avenue, 75 bacteria and 1 mould settled on to the surface of the exposed plate in five minutes before sweeping. When the room was still, immediately after sweeping, a similar experiment showed over 2,700 bacteria and 6 moulds.

Carnelly found in hospital wards in Dundee in the afternoons from 10 to 20 bacteria in 10 litres of air. Neumann found after sweeping from 80 to 140 bacteria, and later in the day from 4 to 10 in 10 litres. On the other hand, Carnelly found in houses which are denominated clean, 180 bacteria in 10 litres of air, while in very dirty houses there were over 900. In dirty school-rooms, with the so-called natural ventilation, he found in the same volume of air nearly, 2,000 living bacteria, while in mechanically ventilated schools there were from 30 to 300.

The writer has found as the result of 23 analyses of the air of various laboratories, lecture-rooms, and hall-ways, at the College of

Physicians and Surgeons in New York, under the ordinary conditions of occupation by considerable numbers of students during March and April, 1890, that the average number of bacteria in 10 litres was 11 and of moulds 14.

The average number of germs in various hospitals and dispensaries in New York during the same period in 10 litres of air, (19 analyses) was bacteria 127, moulds 25.

We thus see that the number of living germs in a given volume of in-doors air varies greatly in different places and under different conditions. We see that the temporary freeing of the in-doors air from germs can be accomplished by simply closing the rooms and keeping the contained air still when within one or two hours nearly all dust and most of the bacteria will have settled to the lowest resting-place. Whether the air shall be permanently rid of its living or inert dust particles or not, will of course depend upon the measures which are resorted to in the familiar performances of sweeping and dusting, of which more by and by.

A good many of these facts which have been just set down in regard to dust, are embodied

in the lore of the intelligent house-keeper, scientific studies having simply given precision to common beliefs and revealed certain qualities in dust, which may possibly render it of greater significence than an annoying and an omnipresent form of dirt.

CHAPTER VI.

THE SAFEGUARDS OF THE BODY AGAINST INHALED DUST.

HAVING now gathered together a considerable number of facts about the distribution in the air of dust particles and among them of living germs, we are ready to consider their significance—if they have any—to human beings, who must live in and breathe this more or less dust-laden air.

The average amount of air which a healthy grown person takes in at each breath has been estimated to be about one half a litre (about 30 cubic inches). We have seen from our various analyses of the air of different places in and about New York, under ordinarily favorable conditions, that the number of living germs in 10 litres of air varies from 11 to 376. So that basing our estimate upon these studies

of the air in this city, with every twenty breaths one may take into his body, depending upon where he is all the way from 11 to 376 living micro-organisms, together with a variable amount of inorganic dust.

The number of living germs which the New York citizen is liable to be forced to take into his body, when the streets are dry and the wind blowing, or when the dry filth is being stirred up by the diabolically careless proceedures of the present street-cleaning fiends, it would be a thankless task to tell.

Now it has been learned, not only from common experience but from long series of careful experiments, that the solid particles which we breathe in with the air either through the nose or mouth do not come out with the expired air, but are retained on the moist surface upon which the air impinges going in and coming out. These foreign particles floating in the inspired air are caught largely in the nose or mouth or upper throat, while a certain number pass down into the air-tubes and lungs. A large part of this foreign material may be discharged from the nose where it is caught in the

mucous which that organ secretes when irritated.

A very considerable proportion of the inbreathed foreign material gets into the mouth and may be spat out or swallowed.

The floating material which is carried past the well-guarded portals of the lungs and enters the windpipe and bronchial tubes and lodges on their moist walls finds here a most efficient arrangement for its expulsion. Here is placed, completely lining the tubes, an army of thoroughfare-cleansers composed of individuals who are not in politics, who have no vote, and who present to us the unwonted, and at first puzzling, spectacle of street-cleaners whose business seems to be to clean the streets. Completely lining the larger air-tubes like a mosiac, are myriads of tiny cells shaped something like a narrow short club and set upon end side by side. Projecting from the free ends of each one of these cells is a number of very minute hairs, so that the whole cell looks something like a short club with a beard growing from one end (see Fig. 3). The whole inner surface of these air-tubes, then, is

lined with these delicate hairs which are called cilia.

Now, these myriads of cilia, year in and year out, day and night, while life lasts, are constantly swinging their free ends back and forth, bending as they recover, and then with a quick

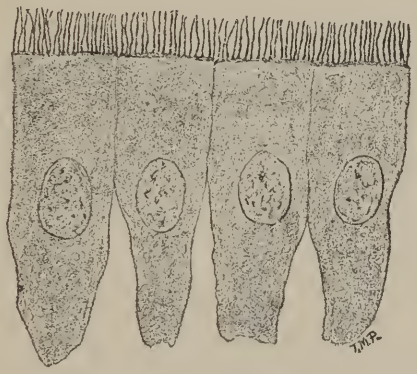

FIG. 3. — CILIATED CELLS FROM THE LARGE AIR-TUBES OF THE HUMAN LUNGS, SEEN FROM THE SIDE. HIGHLY MAGNIFIED.

snap forward so that any small object which lodges on the walls of the larger air-tubes— since all the cilia act in rhythm—is swept upwards toward the mouth, away from the perilously delicate and sensitive lungs.

The movement of these cilia is less vigorous when the body is quiet, as in sleep, increasing

in rapidity and force when the body is active. Almost every one has noticed that shortly after rising more or less mucus or "phlegm" is apt to come up into the throat. This is because the increasing vigor of the ciliary movement, as one's general activity increases, sweeps up the accumulation which the comparative quiescence of the night has allowed to form.

It is a curious thing that these humble but energetic little members of the cell communities which make up the body are apparently the last elements to die when what we sometimes call the vital forces no longer act. The breath ceases, the heart flutters and is still, the blood ebbs and flows a little here and there, the last definite nerve impulses express themselves as now one now another muscle quivers or feebly and fitfully contracts, but still these wonderful little cilia keep swinging on sometimes for hours after all trace of what we have called life has disappeared, and when these too at last are still, and not till then, is life in the body totally extinct.

There is another very curious arrangement in the air passages for the disposition of small

foreign bodies which are breathed into the lungs. There are certain cells in the body which seem to have nothing in particular to do on ordinary occasions but to float about on the blood tides or wander through the various channels and crevices of the tissues watching other cells work. Sometimes they come out and air themselves in the bronchial tubes or in the tiny air-chambers which make up the body of the lungs. But the moment these cells come upon a foreign particle from without or upon a fragment of worn-out tissue anywhere in the body they pounce upon it, wrap themselves around it, and either digest or destroy it or carry it off to some safe place of deposit, either inside the tissues or without. Now these humble scavenger cells are usually quite abundant in the air passages, where they often take up dust particles of one kind or another, and victims to their zeal are not infrequently swept with their booty by the ciliated cells up and away into the mouth. A good deal of lore has accumulated about these little wandering scavengers of the body and they seem to be of great importance in many ways. But, in spite of

their usefulness and the various beneficent things which they do, scientific men have seen fit to make them bear the added burden of the name of *phagocytes*.

But to return to our dust particles. In spite of all the safeguards with which our lungs are furnished against the entrance of foreign bodies, into their deep and delicate recesses and through them into the blood, a considerable number of dust particles of one kind or another do get in and permanently lodge upon those walls of the delicate breathing chambers in the lungs, which are beyond the protecting agency of the ciliated cells. Now right in the walls of these tiny air-chambers of the lungs, where the blood is separated from the inbreathed air only by a film, one of the most important and subtle of the vital process goes on, upon which the continued purity and virtue of the blood depends. Here the blood gives up the carbonic acid and water which it has gathered in its journey around the system, and takes in its fresh supplies of oxygen.

Although persons who habitually work in very much dust-laden air are liable to pul-

monary disease caused by the lodgment in their lungs of foreign particles of one kind or another, and furthermore, although even comparatively small amounts of foreign particles in the lung tissue cannot fail to be undesirable additions to those organs, still it is a fact that the lungs do establish for themselves a considerable degree of what we call tolerance of foreign particles lodged in their tissues. That is to say, there may be a good deal of accumulation of foreign material in the lungs without any appreciable interference with the health, because the body here, as in many other ways, has the power of adapting itself to unusual and even harmful conditions.

In fact, the lungs of nearly all adults who live under what we call civilized conditions, that is, in houses with considerable smoke and dust in the air, in cities which have street-cleaning done for political purposes only, or in manufacturing regions where there is much smoke, instead of being of a delicate spotless pink color are dotted all over with spots and streaks and patches of inhaled dust-particles which the body has not been able to get rid of but has stowed away

permanently in the tissues in such situations as will least interfere with the action of the lungs (see Fig. 4). Here it remains as long as life lasts.

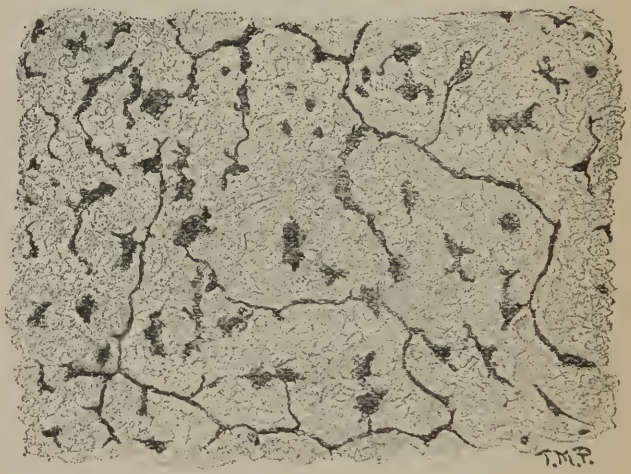

FIG. 4.—PIGMENTATION OF THE LUNG FROM INHALED DUST.

A small portion of the surface of an adult human lung which has become pigmented by the inhalation of dust. This drawing was made not from the lung of a coal miner or one who had lived in especially smoky or dusty places, but from that of an individual exposed to the ordinary conditions of in-door city life.

But we have not yet finished with the safeguards which the body has placed for itself against inhaled dust. For, however success-

fully the lungs may stow it away in considerable quantities, there is a very curious provision against its further entrance to and distribution in the body. This is the way that is provided against. As the blood circulates through the lungs as well as in every other part of the body, a small amount of its fluid part, conveying an abundance of nutriment, oozes out through the walls of the vessels into all the minute clefts and crannies of the tissues where the cells lie and bathes and nourishes them. Now, having done this, the nutritive fluid—which we call lymph—is gradually collected into a series of irregular narrow vessels which open into large and still larger trunks until finally it is poured back into the blood, of which it again becomes a part.

If this lymph which has searched out every remotest corner of the body to which it was distributed should have become contaminated or polluted by any harmful or foreign material which it had come across in the tissues, it would carry it straight back and pour it into the blood, where it might cause dire results, since the blood is an extremely important and delicate juice. But fortunately the lungs, as well as

several other important organs of the body, are provided with a series of very efficient filters, through which the lymph has to pass in its transit toward the blood current with which it is to mingle. Now several of these living filters, which we call "lymph-glands," little reddish-white bodies, are grouped deep in the chest at the root of the lungs, and are so very effective that, although the lungs may be crowded with inhaled dust particles stored away permanently in out-of-the-way places, and the lymph filters may finally become themselves as black as your hat from its accumulation (see Fig. 5) the dust rarely gets through them and into the blood or other parts of the body.

Thus far, in considering the safe-guards of the body against inhaled dust, we have been thinking only of those lifeless particles of one kind or another which make up the inorganic part of dust. How is it with bacteria,—with those dust particles which are quite inert when dry in the dust, but which, when the moisture and warmth and food they need are furnished, may grow and multiply with great rapidity.

In answer to this, it should be said that not only does the body afford the same safe-guards against these living germs as against other dust particles, as just described, but most of the different kinds of germs which are floating

FIG. 5.—DUST FILTERS IN THE LUNG—DEEPLY PIGMENTED.

A drawing of one lobe of a human lung, showing the lymph filters (lymph-glands) at one side, which have caught so much inhaled dust in their meshes—thus keeping it out of the blood—as to have become almost totally black. These glands are naturally of a light-pink color.

in the air do not grow in the human body in any appreciable degree; the soil is not good for them. Some do not find in the nose, or the mouth, or the lungs, the proper food or conditions which they need, others are actually killed off sooner or later, either owing to some

quality in the body juices which is quite inimical to their life, or by those vigilant *phagocytes* which we have noticed above—or perhaps in other ways which we do not yet know any thing about. The germs which are swallowed after being caught in the nose or mouth from the inspired air, or swept up from the air-tubes by the ciliated cells, are, for the most part, soon deprived of life by the digestive fluids.

There is one species of bacteria which we are to learn more about presently (the tubercle bacilli) which. when they lodge in the tissues, sometimes stimulate the cells near them which multiply and build up a dense enclosing wall about the intruding germs, so that these become imprisoned in a little bag or sac in the body, and can neither get away, nor spread, nor do further damage. They are sometimes so cut off from nutriment, that they die, or at best sustain for some time, a poor and meagre existence. (See Fig. 6, p. 69.)

There are individual conditions of the body in which it affords a most obstinate resistance to the incursions—that is, the growth of bac-

teria within it. There are other conditions in which it seems fairly predisposed to their growth and ravages. What the nature of the conditions is, which in one individual or at one time confers immunity to harmful bacterial growth, and at another renders it predisposed to their ravages, we do not know. But very zealous workers are busy with the problem, and we may hope in due time to get light and confidence in this obscure field, where we can now but feebly grope.

CHAPTER VII.

THE REAL SIGNIFICANCE OF DUST IN ITS RELATION TO DISEASE.

BUT why then, it may be asked, all these sinister allusions to the danger of dust, if, as we have seen in the last chapter, most of it is caught before it gets into the lungs, and that which does get in is disposed of in such clever ways? This question brings us at last face to face with the gist of the whole matter.

The body does rid itself of a great deal of the inhaled inorganic dust which lodges in the nose and mouth and air-tubes of the lungs. It does do the best it can to dispose of that which is permanently stowed away in the lung tissues themselves. It does without more ado kill outright or otherwise make way with most of the living germs. But when all this is accomplished there still remain certain important ways in

which dust particles of one kind or another may do serious harm to human beings.

We shall do well in considering these harmful effects of dust to separate in our thought its inorganic from its germ ingredients.

The inorganic elements of dust when present in large quantities in the inhaled air may, as we have seen above, cause well-defined disease of the lungs by the persistent irritation which they induce. But as it is only under exceptional conditions, as among coal-miners and grinders and other workers in confined places where these solid particles are set free in great numbers that this occurs, we need not consider them here. Very moderate amounts of dust particles in sensitive persons cause such a degree of irritation of the respiratory organs as either to deprive them of robust health or predispose them to the aquirement of various diseases which with unirritated lungs they would readily resist.

There is no doubt that a great deal of misery, if not positive disease, is caused by the inhalation of dust in the persistent coughs and

more persistent protean catarrhs with which so many persons otherwise healthy are burdened.

Then again dust may produce much distress when not inhaled, by irritating the eyes to such a degree as to cause great discomfort, if not positive disease.

The pernicious and noxious elevated railroads have brought some parts of New York into a condition very much akin to certain coal mines, with the large amounts of dust and fine cinders which they shower down upon the streets and into the adjacent houses and into the eyes and lungs of the pitiable citizens of this metropolis.

As to the bacteria about which our main interest centres, there are unfortunately a few species which, when they once find lodgement in one place or another in the organs of respiration, may grow and multiply, and successfully resisting all the protective agencies of the body, set up distinct, persistent and even fatal disease. Those forms of bacteria which can or in these regions commonly do this, are insignificant in number in comparison with the

harmless species with which dust is usually swarming. But few as they are they have an extreme significance. If it were not for these few species of disease-producing bacteria most people could perhaps afford to be as indifferent as they are to dust and its dangers.

We have seen that the large numbers of common bacteria which are omnipresent in the air are growing all about us and get into the dust in many ways which we not only cannot control but do not very much care to control, since in moderate numbers they are essentially harmless, or at least do only such damage as other inorganic dust particles may do. But with the bacteria which cause disease the case is entirely different. They do not flourish apart from the bodies of men and animals. They may remain alive for a good while outside of the body, and some of them may grow a little under some few special conditions. Some of them are frequently present in the healthy human body.

But after all when we seek for the active breeding-places and sources of distribution of the bacteria which frequently cause disease in

man in this region, we find that they are the bodies of persons, and occasionally animals, suffering from the diseases which the bacteria cause. It is the presence of these bacteria in large numbers given off from the body, which makes these diseases what we call contagious or infectious.

If we could completely isolate all those persons or animals who are at the present moment harboring the few known species of bacteria which produce disease in man, such diseases could be completely stricken from the list of human ills, unless they were lighted up afresh by some of the discharged material which on walls, or garments, or in the soil, or in the aërial dust, still retained vitality. At any rate, if we could be certain that the discharged material from such sick people were immediately destroyed we should be able to limit within narrow bounds those diseases which today carry off, prematurely, the larger part of those who do not die of injuries or of old age. They are thus, at least ideally, preventible diseases.

But this matter of preventing the spread of

bacterial disease by means of dust is of such extreme importance that we must be very certain that we are dealing with facts and not with conjectures, when we consider the relationship one to the other. Let us then get the facts together first.

There is a large number of diseases which physicians call *infectious;* these all have certain ways of manifesting themselves, certain family traits which would justify this grouping of them together even without a knowledge of the particular agent which causes them. The more important of these infectious diseases are: consumption or tuberculosis, diphtheria, small-pox, yellow-fever, Asiatic cholera, typhoid-fever, scarlatina, measles, pneumonia, erysipelas, and blood-poisoning. There are others of less frequent occurrence in this region, which we need not mention here.

Now within the past few years we have found out positively and without question that the particular and exclusive agent which causes some of these diseases is one or other form of bacteria. Each disease has its special form of bacteria, without which it can by no possibility

exist. The particular species causing some of these diseases have been isolated and studied and experimented upon in so many ways and by so many workers that we feel perfectly certain about them. Among such diseases are: consumption, typhoid-fever, Asiatic cholera, erysipelas, some forms of blood-poisoning, and diphtheria.

Concerning the kinds of germs which cause many other of the infectious diseases we are yet in doubt. We have an increasing conviction that they are also caused by some form of micro-organism or germ, but what it may be and how it acts is not fully determined.

Among those infectious diseases the exact causes of which have not yet been made out may be mentioned small-pox, yellow-fever, measles, and scarlatina.

Now to make a long story short, and to give precision to our theme, I purpose to limit this consideration of the relationship of dust to disease largely to that one bacterial malady which is most important and which we know most about and which we can do most to prevent, namely, consumption or tuberculosis.

Many of the conclusions to which we shall be forced, and many of the practical hints as to personal action which we shall gain, apply equally to some of the other bacterial diseases. But these other diseases are apt to make people early and more or less seriously ill, and so they come under the charge of the physician, who should on the spot suggest measures to prevent their spread. On the other hand, persons affected with consumption very frequently go about for weeks and months among their fellows, always liable, through ignorance or carelessness, to transmit the disease-producing germs to others, as well as constantly repoison themselves, and thus greatly diminish the chances of recovery which they might otherwise anticipate.

It is most important then that everybody should have some definite knowledge about the cause and mode of spread of consumption, since it spares no age and no class and is the most widespread and fatal of all the diseases known to man, and is in large degree, could we but secure thorough cleanliness in the air we breathe and the food we eat, a distinctly preventible disease.

CHAPTER VIII.

CONSUMPTION AND THE WAYS IN WHICH IT IS SPREAD BY DUST.

THE germ which causes consumption or tuberculosis is a minute slender rod-like body about one ten-thousandth of an inch in length, and is called the Bacillus tuberculosis. It does not grow in nature outside of the bodies of men and a few species of warm-blooded animals. It may, however, remain alive for a long time when dry as in the soil or air.

In the bodies of some animals and in the bodies of many men it does not ordinarily flourish or even grow at all, for reasons which we do not understand. The proper temperature may be present and moisture and nutritive material in abundance, but for some unknown reason it will not grow. There are other individuals and other animals which seem to

furnish the unknown conditions, and in them the bacillus grows more or less rapidly; such persons or animals are said to be predisposed to the disease—consumption.

A great deal of misery and wearing apprehension have been caused in the years which are past by the widespread notion that consumption may be inherited. Modern researches show that this notion is not well-founded. It is true that there is a subtle make-up of the body cells in certain persons, some entirely mysterious nutritive condition, which renders their bodies especially favorable for the growth of the tubercle bacillus, and that this indefinite and ill-understood peculiarity may be inherited. But that is all. If the tubercle bacillus can be kept away from them, even predisposed persons cannot get consumption, for this disease without the bacillus cannot exist, and the bacillus does not as far as we know pass from the mother to the unborn child. But this so-called predisposition is not always inherited; it may be and often is acquired, sometimes in ways which we know about, sometimes in ways which we do not fully understand.

When the tubercle bacilli get into the bodies of predisposed individuals and begin to grow they stimulate the tissues about them so that little new-formed masses of cells appear about and among the growing germs. These cell masses are called tubercles. Sometimes larger masses of new cells are developed, which replace considerable portions of the tissues and organs in which the bacilli have lodged. After a time, especially in the lungs, the new-formed tissue, containing sometimes enormous numbers of the living tubercle bacilli, gradually disintegrates or breaks down, and this broken-down germ-laden material may then be discharged with the mucus from the bronchial tubes day after day in considerable quantities for months or even years, in the expectoration, new bacilli forming as fast as the old are discharged and sometimes even much faster.

Tuberculosis may have its seat in other parts of the body than the lungs, but with the lung affection alone we are now concerned.

This then is the great primary fact which is of extremest significance to us in our present study; namely, that *every person suffering*

from consumption of the lungs may be expectorating every day myriads of living and virulent tubercle bacilli, and that the life and virulence of these bacilli are not destroyed by prolonged drying.

Now leaving this fact for a moment, let us see how common a disease consumption or tuberculosis is after all.

From one seventh to one fourth of all the people who die are carried off, most of them prematurely, by this disease. In Europe about one million persons die each year from consumption, that is about 3,000 every day. In the United States in the year 1880, that is, the year of the last census, over 91,000 persons fell victims to this disease, and the average age at death of these persons was thirty-seven. Let him who has watched the progress of this insidious disease in but a single case, imagine if he can the misery and pain which these figures represent.

The disease is considerably less frequent in some regions and countries than in others, but everywhere where men live together in large numbers, or live under bad sanitary conditions

in-doors, this disease claims its numerous victims when once it gains a foothold.

Our attention is not ordinarily called to the large numbers of persons who sicken and die from consumption, because we have become so accustomed to it that it is taken as a matter of course,—one of the inevitable ills of life. When yellow-fever or small-pox or Asiatic cholera threaten to spread among us, we are on our guard at once, and from the medical profession and the press come such warnings that no pains are spared in public or in private to stay their progress. And yet the number of victims of these occasional and dramatic epidemics is quite insignificant as compared with those of our omnipresent consumption.

We dread outbreaks of small-pox and carefully guard ourselves against its spread, but in the State of Michigan, which is typical of many others, in 1886–87 there were from forty to fifty times as many deaths from consumption as from small-pox. In the State of New York in 1887 there were reported 96,453 deaths, and 11,609 of these were from consumption.

A glance over the mortality in various cities in different parts of the world, as it comes to us in the very latest reports, shows everywhere the same story. We find in Dr. Tracy's report to the Health Department of New York City for the week ending March 22, 1890, that in New York City, out of 772 deaths from all causes, 121 were from consumption. In Chicago, out of 2,072 deaths, 178 were from consumption. In London, out of 1,889 deaths, 206 were from consumption. In St. Petersburg, out of 617 deaths, 128 were from consumption. In Paris, out of 1,214 deaths, 248 were from consumption. In Vienna, out of 470 deaths, 116 were from consumption. In Berlin, out of 650 deaths, 96 were from consumption.

These are the bald relentless records of the deaths. But who shall adequately picture, or even remotely conceive, the shattered ambitions, the long weary hours of distress and suffering and struggle, the slow weeks and months, lighted fitfully now and then by gleams of fictitious hope, which lead to the last long release. And what shall be said of the desolated homes and scattered families, and pov-

erty and want and crime which among the poor are wont to cluster about and to follow such premature and lingering death? Probably the actual suffering and distress caused by all other diseases put together is far less than that which in one way or another is associated with consumption.

Now where do all these people get this most widespread disease? How do they become infected? Where do the living bacilli of this particular species come from which get into their bodies? They do not grow at the temperature of the air out-of-doors. There are no lurking-places for them in nature apart from those men or animals who have the disease. Plant them artificially with other common bacteria in tubes in the laboratory and they die; they succumb in the struggle for existence with the harmless species of the earth and water and air.

In a certain number of cases they no doubt are taken in with the food, and inasmuch as tuberculosis of cattle is a very common disease all about us, there is every reason for believing that the infection often enough occurs through

the use of uncooked meat or milk. That the consumptive mother may infect the nursing child with its food has been abundantly proven. There are cases in which the tubercle bacilli get into the blood and are distributed to all parts of the body, setting up such innumerable foci of disease that the individual soon succumbs to the violence of the poison.

But after all, the prevailing seat of consumption being in the lungs, the most natural supposition is that the larger proportion of consumptive people become infected through the inhaled air.

Now, as has been absolutely proven over and over again, in almost all populous regions, both out-of-doors and in-doors, tubercular persons may be discharging thousands of living tubercle bacilli every time they spit out material from their lungs upon the streets, or upon the floors, or wherever it can dry and mingle with the dust. If the tubercle bacillus is not easily killed by drying, as has been fully proven, have we not a sufficient explanation of the way in which the infection of tuberculosis becomes so widely and perpetually spread?

If this be true,—that tuberculosis is spread by the breathing in of tubercle bacilli in the dust of the air, then, it may be said, we ought to be able to find these particular germs in the dust of rooms inhabited by consumptives. This is by no means an easy task, because our means of identifying this germ are rather complex, and require for their execution much time and skill. But notwithstanding this, Cornet, in Berlin, has over and over again, in the dust high up on the walls of consumptive wards of hospitals, in the dust of private houses, and hotel rooms occupied by consumptive patients, found living virulent tubercle bacilli. But he found these only in cases in which the discharged sputum was not carefully and at once destroyed, but was permitted to lodge upon floors or clothing or articles of furniture, where it dried and finally became pulverized and carried as dust to such parts of the room as are not ordinarily cleaned.

Again, some one will say: "If it be true that consumption is apt to be acquired by breathing in of the bacilli with the dust, then we ought to find in the lungs of persons who have died

from other diseases not infrequently the commencements of tuberculosis." Now this is in fact just what we do find. It is very common, indeed, to find in those little filters at the root of the lung,—the lymph-glands which we have spoken of in another chapter,—both in adults and in children small areas of tubercular disease, and nothing else in the whole body indicating the presence of the germ. The disease here has not been extensive enough to cause any ill effects or give any symptoms. It may be in an early stage or it may have existed for a long time, or it may have altogether healed, leaving only its unmistakable traces behind (see Fig. 6).

But more than this, even, we have learned about the early stages of this disease. Dr. H. P. Loomis has in several cases of accidental death in apparently healthy persons examined these lymph filters (lymph-glands), and found them in appearance perfectly healthy, and yet on applying one of the most delicate and effective tests, has found that after all they did, in a considerable proportion of the cases examined, contain living tubercle bacilli. These

were present, but had not yet set up even a local disease.

It has been shown, by a careful series of recent observations, that when due care and intelligent cleanliness are provided for, the attendants upon consumptives in hospitals and in private houses, are not subject, in any marked degree to the acquirement of the disease. But, on the other hand, it has been equally fully proven that when proper cleanliness is not exercised, and the expectoration of the patients not intelligently cared for, the attendants in hospitals for consumptives have in very large proportion fallen victims to the disease.

More proof than is in our hands is hardly needed that in a very large proportion of cases in inhabited regions the infection or germ of tuberculosis is conveyed from sick to well persons by means of the material discharged from the lungs, which is allowed, from carelessness or ignorance, to dry and finally mingle with the floating dust.

While thus tuberculous persons *may* be a constant source of danger to their healthy fel-

lows, it is by no means true that they always are or ever need to be. *The breath itself, the*

FIG. 6.—LYMPH FILTERS (LYMPH-GLANDS) AT THE ROOT OF THE LUNG, THE SEAT OF LOCAL AND HEALED TUBERCULOSIS.

Two of the lymph filters at the root of the lung which have become blackened from inhaled dust. But in addition to this, one of them—the larger—shows two white spots which are caused by the lodgment here of the tubercle bacilli. These germs, caught in the meshes of the filter and thus kept out of the blood, have grown here for a time. But owing to their growth or their presence, the tissues about them have been so stimulated or irritated, that a dense organized wall has been formed around the germs, completely shutting them off from the rest of the body. This is the way in which the cure of consumption is sometimes effected. Nowhere else in the body of this person, who died from an acute disease, were there any evidences whatsoever of tuberculosis.

exhaled air of consumptives, no matter how seriously ill, is not dangerous; it carries no germs. It is only the solid discharged material of the sputum which carries the danger. And this sputum, moist and usually adherent as it is when fresh, is only dangerous, so far as contamination of the air is concerned, when it is permitted to dry.

Here we seem to be at the root of the evil. The reason why consumption is so widespread and the most important element in this appalling mortality is simply that consumptive persons, either from ignorance or carelessness, are distributing the poison not only everywhere they go, but everywhere the dust goes which has been formed in part by the undestroyed germ-laden material expelled from their lungs. This is what has been mistaken for so many years as evidence of the hereditary transmission of consumption, as proof that consumption "runs in families." The house-mates have unwittingly poisoned one another, usually, no doubt, through the dust. We are but just beginning to recognize this. We have, indeed, known what caused consumption but a very

few years, and even many intelligent physicians are not yet sufficiently impressed with the inexpressible importance of scrupulous cleanliness in tuberculosis to urge it as they should.

The way, then, to most efficiently stop the prevalence of this *distinctly preventable* disease is evidently to see that the sputum of consumptives is properly disposed of. When this is practicable it should be received in small paper cups,[1] made for this purpose, and as soon as possible burned. The reception of the sputum upon fabrics of any sort is always to be deprecated.

The reason why the use of cloths or handkerchiefs for the reception of the expectoration in consumption should be as much as possible avoided is that on these the material very readily dries, and, becoming detached with or without the minute particles of fabric, readily floats off in an inhalable condition into the air. For the same reason, great care should be exercised by consumptives to avoid the soiling by sputum of woollen garments from which

[1] These are now in the market and sold cheap by druggists.

very fine fibre particles are always very readily detached, and would carry with them dried particles of germ-laden material, should such have been allowed to fall upom them.

But if cloths must be used, as will often be the case, either to receive the expectoration or for wiping the mouth, they should be such as can be as speedily as possible burned with their contents. When handkerchiefs are used they should be as early as possible boiled for a full hour in a receptacle by themselves before they are washed in the ordinary way. Cheap paper cuspidores are now made which should be placed in all apartments frequented by consumptives, and frequently changed and with their contents burned.

The greatest drawback in the suggestion of such rules of procedure as would be efficient in preventing the spread of tuberculosis is the certainty that they will not, in a great many cases, be followed. Persons who are cleanly enough in private houses will spit upon the street, or in public conveyances, or on the floor of theatres and other places of assembly, and until the knowledge that the sputum of

consumptive persons may be dangerous shall have become widespread, our efforts in the direction of the prevention of this disease will continue to be counteracted by the misdeeds of the ignorant and careless.

Consumption is at best, if it has any best, a most distressing and deplorable malady. But when we have learned, as we have within the last decade, that the chances of recovery are often very good indeed ; that it is not hopeless, as was formerly believed ; that it is not inherited ; when we appreciate that with due care the stricken one need not in the least be a source of danger to others, even to his housemates ; when we fully realize that the appalling prevalence and mortality of the past has been due to ignorance of the nature of the disease and the mode of its transmission, we should be able to appreciate how much we owe of comfort and of hope to the investigations in scientific medicine, which have given us all this, if they have not yet brought to us such means as will directly cure the disease in individuals when once firmly established.

CHAPTER IX.

DUST-DANGERS OUT-OF-DOORS AND IN PRIVATE HOUSES, WITH SUGGESTIONS FOR THEIR AVOIDANCE.

WITH all these facts about the most common way in which consumption is transmitted from one to another before us, we are ready to consider what the places are in which healthy persons are most likely to be forced to breathe air which contains this or other infected dust, and what should be done to avoid it.

It should always be held in mind, in considering the facts and suggestions which this chapter contains, that the safeguards of the body against inhaled germs, which we have already looked at in another chapter, are constantly in action, and in large degree, in many persons, actually and wholly protect

against danger, even in very dirty and very infectious places. Many disease-producing bacteria soon die, in greater or less numbers, soon after they are expelled from the bodies of sick persons; many are swept away by the winds into uninhabited regions; many fail to come in contact under favorable conditions with susceptible human beings. But these natural safeguards cannot be implicitly relied upon for safety by any one at all times, nor can any one with impunity overtask their capacities by unnecessary and constant exposure of his person to infectious dust.

It is certain that in the out-of-doors air in the country, and also in cities whose streets are kept decently clean, there is little danger of harm from the inhalation of germs of consumption or of any other disease, because the constant purifying agency of wind and air currents will either soon sweep away the dust or so largely dilute it that it will be practically free from disease germs, the sources of which are so comparatively limited. If, however, the streets of cities be or are allowed to remain filthy, so that abundant and pretty constant

dust-clouds are encountered by those passing through them ; if the streets are not properly sprinkled before sweeping, either by machine or hand ; if ignorant or careless street-cleaners are allowed to scatter clouds of dust about them as they sweep or shovel or transport the pulverized filth, the chances of inhalation of dangerous dust particles are proportionally increased. But, on the whole, the risk of infection out-of-doors from dust, even in crowded towns, unless they are notably filthy, is not actually very great.

Indoors, however, the conditions are entirely different. Let us first consider private houses and living rooms. Here, as we have already seen, the sources of micro-organisms are various, but we need consider here only those which cause consumption. These may be brought in on feet and garments from the streets or other places, or be blown in through open windows or drawn in by other modes of ventilation. If there be no consumptive persons in the house or rooms, these chance sources of infection are all that need be regarded. If there be consumptives in the

rooms, no further danger need be feared if the material which they expectorate be scrupulously attended to in the manner already indicated. If, on the other hand, consumptives are permitted to discharge the material raised from the lungs on floors or elsewhere where it may dry, this will be a source of danger far exceeding all others. In houses where healthy persons are, then, or in houses where consumptives are who are intelligently clean in their habits, the chances of inhaling the tubercle bacilli are slight. But it should always be remembered that these chances, whether small or great, are directly dependent upon the means which are used to get rid of the dust. If this be permitted to accumulate so that it is liable to be stirred up over and over again by the movements of persons in the room, by so much will the risks be increased of inhaling the harmless germs of dust and with them sooner or later, the dangerous ones, should such by chance be present.

It is perfectly obvious that unless the windows be widely open or liberal air currents in some way established, the too common method

of so-called "dusting"—that is, the stirring up of the dust which has settled on the smooth places in a room so as to allow it to settle again on to the rough surfaces or inconspicuous places where it does not show—is worse than useless, since the dust and germs are not in this way got rid of, but only redistributed and put for a time in a situation suitable for inhalation.

Carpets and heavy hangings and upholstery with rough goods all insure the more or less persistent retention of dust particles in rooms and with these the harmful germs, if such are present.

Hard floors, with rugs which may be cleaned out-of-doors, as few and as light hangings as are practicable, furniture upholstered as far as may be with smooth-surfaced fabrics, the use of moist dusting-cloths, and the wide opening of windows and doors when cleaning is going on,—these are the general suggestions, which, if followed, will confer in a large degree, even in populous towns, a sense of security against the dangers of dust in private houses in which healthy persons live.

We need here only call attention in the

briefest way to many devices in the lore of the enlightened housekeeper for cleaning of carpeted floors without raising clouds of dust which seem more objectionable the more we know about them. Such practices as the sprinkling of carpets with coarse salt, or salt and bran, or moist tea-leaves, or other substances which keep down the dust: the use of some of the more perfect forms of carpet-sweepers, etc., may be brought to bear in solving the problem of clean living places in towns.

The writer can perhaps imagine the fine scorn with which his meek suggestions in this direction may be met by the experienced housekeeper, and indeed makes no virtue of insisting upon method so long as the removal, and not the simple redistribution of the dust, be the end accomplished.

In houses and larger buildings which are supplied with a system of forced ventilation, or wherever the ventilation-draught is strong enough, a great deal may be accomplished in the way of keeping the dust out of the buildings by the use of cheese-cloth or thin cotton batting screens placed across the air currents near the entrance of the ventilation-shafts.

CHAPTER X.

DUST-DANGERS IN PUBLIC BUILDINGS AND PUBLIC CONVEYANCES.

WE come now to another class of places in which dust is a matter for very serious consideration. I mean theatres, churches, schools, and court-rooms and other places of assembly in-doors where large numbers of persons are frequently crowded together. Here the individual in the matter of the cleanliness of the air he breathes is largely at the mercy of his fellows, and especially of the persons too often ignorant and careless to whom is intrusted the more or less frequent sweeping, dusting, or other cleaning of the rooms.

So prevalent is consumption, and so insidious in its onset that there are very few large assemblages in which some victims of the disease are not present. Such persons, if not

informed of the danger of the practice, will be apt to convey some of the material discharged from the lungs to situations in which without care and vigilance on the part of those who afterwards clean the rooms, it may form a part of inhalable dust.

Many of the theatres are probably the most likely places of any which we know frequented by healthy persons in large cities for the inhalation of disease germs of one kind or another, especially the germ of tuberculosis. The ventilation is usually wholly inadequate even for the purpose of carrying off the vitiated air of respiration or exhalation, and is of almost no use in freeing the air of dust. Close walled they are apt to be, so that large volumes of out-door air rarely or never sweep through them, carpeted and the chairs upholstered in plush, visited by large numbers of all kinds of people who, in the long sittings, pretty generally thoroughly cleanse their shoes on the carpets, if they do not add to this their salivary contributions. The floating particles accumulate in theatres in enormous quantities, in such quantities, indeed, that the tell-tale elec-

tric light beams show a blue or gray cloud on most occasions where they pierce the dust-laden air. Now, it is a fact that in most theatres at least there is no efficient means made use of to get this accumulating dust out of the auditorium. The coarser dirt is swept up more or less frequently in all of them, and carried off, but the finer dust is usually simply stirred up again in a perfunctory and wholly useless way from the seats to settle back again into the plush or the carpets, to be stirred up anew by the incoming and outgoing audience. The fact is, the upholstering of the chairs of public assembly-rooms ought never to be done with plush or other rough fabric which catches and holds the dust. The floors should not be carpeted, as there are plenty of other wholesome substitutes, and both the ventilation and the daily cleansing ought to be done under some intelligent direction, so that these places need not continue to be, as so many of them now are, veritable death-traps and distributing centres of bacterial disease. While there are, of course, exceptions to the condition of affairs which has here been described, the exceptions

are not by any means always or usually the more fashionable or popular theatres.

This matter of enforcing reasonable cleanliness in theatres and other places of assembly rests, as all other matters of sanitary reform ultimately do, with the people themselves. So long as the patrons of filthy theatres, either fashionable or not, permit themselves to remain the victims of ignorance or carelessness or cupidity the managers of theatres will doubtless continue to do just what they have been doing and are doing, no matter what in their practices is shown to be dangerous.

Whoever has had occasion to visit the court-rooms in the city of New York—and similar conditions are widely prevalent in court-rooms as well as legislative halls elsewhere in this land—cannot fail to have been impressed with the general filthiness and dustiness and stuffiness which is so pronounced. With the evils which vitiated air causes all are more or less familiar, but to these evils even the large intelligence of the members of the legal profession usually supinely submits. That poisoned dust should be added to the burden simply because

there is no general protest against the carelessness or ignorance which is displayed in the so-called cleaning of these places, seems almost incredible when the importance of the matter is once realized. In the same deplorable condition are many of the public school-rooms in both large and small towns. Ventilation is slowly becoming recognized as important, but the removal of dust, which in crowded places is very liable to be infectious, is not systematically attended to.

Public conveyances into which, especially in this country, people are huddled indiscriminately, are very rarely properly cleaned and dusted. Of course, in these it is not the ordinary inorganic dust, the fine coal or iron or sand particles which are most to be dreaded, but the materials which come from uncleanly travellers who are the victims of bacterial disease. The dangers will be removed only when the travellers themselves realize that the disgusting and very prevalent habit of spitting upon the floor of public conveyances is not only filthy but may be positively dangerous, and the managers of the transportation com-

panies see to it that their conveyances are actually frequently cleaned.

A railway-car which comes in from its hundred-mile trip is, when vacated by its occupants, usually an extremely filthy place; dangerous even, if by chance it has borne an uncleanly passenger afflicted with bacterial disease. And yet, as every observant person who travels much has often seen, these cars may be started out on the return with their full loads of fresh victims, after no other cleaning than a few random broom-sweeps and a few flips of the feather-duster over the window-seats and plush-covered chairs—the windows usually tightly closed meanwhile, and the doors, possibly, but by no means always, opened.

But here again, if the travelling public will not protest against the filthiness of many public conveyances, and insist upon a more intelligent and careful system of cleaning, matters will probably remain as they are. Where competition exists between the transporting companies, persistent public protest will in the end be heeded. Where competition does not exist, woe to the traveller.

Sleeping-cars and the state-rooms of steamships and hotel bedrooms are almost always liable to contain infectious material, if they have been recently used by uncleanly consumptives or those ignorant of the danger of their expectoration. When the infectious nature of consumption becomes more generally appreciated, hotels and transportation companies over long routes will be compelled to provide special accommodations for such persons as are known to be thus afflicted. In the meantime, more careful attention to the cleaning and dusting (that is actual removal of dust) of such places will do much to mitigate the evil. In public buildings with bare floors the use of properly-wetted sawdust, sprinkled over the floors before sweeping, should be more generally followed than it is.

CHAPTER XI.

SOME OBJECTIONS, PROTESTS, AND QUERIES ANSWERED.

MANY usually very reasonable persons, when brought face to face with such disagreeable facts as have been here set forth, are disposed to petulantly exclaim that they and their friends have got along very well thus far with the dust which they have encountered, and that they don't want to be worried with the possibilities of danger which may lurk unseen about them. The world's people, they say, have managed to live along in large numbers for a good many centuries without knowing any thing about the bacteria which may be sporting in this excellent canopy, the air.

To these rather short-sighted and impatient expostulations it may be answered : The fact still remains that about one out of seven of

all the people who die are prematurely carried off by tuberculosis, and a large proportion of these through dust-poisoning, which if we choose we can largely prevent. We are apt to forget that, as soon as we know the cause and the means of prevention of a disease like consumption, the responsibility for a large death-rate is no longer to be laid to the charge of Providence or fate, but at the door of human ignorance or carelessness. We are apt to forget, too, that such dangers from uncleanly air are constantly increasing with the crowding together of large numbers of people in cities, and especially in cities in which the management of municipal affairs is in the hands, not of intelligent and honest men, but of political tricksters and unjailed thieves.

We pay the penalty of the close huddling together of large numbers of people in cities, by the increasing vigilance which we must exercise to prevent the spread of infectious disease. We may deplore the necessity for such homely and incessant painstaking as is imperative if we would keep our living-places clean and wholesome ; we may carp and cavil at sanitary

preachments if we will, but we ignore them at our peril. Rich or poor, high or low, ignorant or learned, all are alike liable to become the victims of such diseases as are spread in the floating dust of ill-kept towns and dust-ridden houses.

If the prevention of the spread of consumption were a matter which could be carried out by physicians alone there would indeed be little use in inciting a general apprehension of the dangers of dust-poisoning. But, unfortunately, this is not possible. If we are, in any large degree, to limit the ravages of consumption, and with it the evils of many other bacterial diseases, this must be done through the thorough understanding of the danger and its nature by the people at large, and the practice of proper cleanliness in the houses which they directly control, and also by forcing cleanliness upon the managers of public places, which in the end they also ultimately control through public opinion.

If it be not worth while to save one out of every eight or ten or one hundred or one thousand from the distress and pain and misery of

the consumptive's lot, then such considerations as have been urged in this book are worse than useless. But if, on the other hand, the moderate care and attention to cleanliness in the places in which we live or which we frequent is but a small price to pay for the large immunity from disease which would surely follow, then the end in view would seem fully to justify any pains which we may take to make and keep our living-places clean and wholesome.

Many are disposed to assume that in towns whose affairs are administered by dishonest or careless officials the task of cleanliness in houses is a nearly hopeless one, and this, in a measure, is true. But we are too prone, in this country, to permit ourselves to be imposed upon in countless ways without protest, and with a supineness or indifference which is little short of disgraceful.

There is probably no city or town in the United States which need be either misgoverned or filthy, if only the respectable people would intelligently unite in the assertion of their rights. In the matter of dust and street dirt, in which regard the city of New York is

in such a desperate case, much more is involved than individual right or personal comfort. We virtually condone manslaughter just as long as we permit men to hold municipal offices who fail in their plain duty in the protection of the public health. From mayor to scavenger they should be held personally responsible, and no political chicanery permitted to obscure or call away public attention from the business which such persons are appointed and paid to attend to. We owe a great deal to the vigilance of the press in calling attention to sanitary abuses, but without the steady and persistent urgency of individual protest this is of but little avail.

Until the recent revelations in bacteriology gave us firm ground to stand upon in forming our conceptions of the cause of contagious and infectious diseases, there was something most mysterious and dreadful, and the more uncanny because mysterious, about the agency which could so subtly convey a dreaded disease from one to another. That invisible thing which could linger about a room or cling to a folded

garment for weeks or months—which could pass unseen through the air and work desolation far away—was something which might well inspire awe, if not superstition.

To-day, however, the whole aspect of affairs has changed. We have at last found out that these subtle agencies in the diseases of this class which have been most fully studied, are well-defined organisms which we can isolate and cultivate and study, small as they are, with as much precision and certainty as we can cabbages and pumpkins. We know a great deal about the conditions which favor their growth, and various things which, at least outside of the body, will kill them and render them harmless.

With this definite knowledge about some of the agents (bacteria) which cause disease, the most impenetrable of the mysteries clustering about the infectious diseases have passed away. For while we do not yet know, as we have seen in another chapter, the exact form or species which is concerned in causing all of the diseases of this class, we have indisputable ground for assuming that they all are caused

by some formed, minute, living thing, either plant or animal. This leads us to the further definite conclusion that whenever one of the contagious or infectious diseases is conveyed from one person to another, this is done by formed material which must pass from one to another, either in the shape of palpable solid matter or by fine floating dust-particles.

Now, when we interpret this rather long exposition of facts and inferences into every-day experience, we find that it means something like this: When we have in the house a victim of one of the infectious diseases, such as diphtheria or consumption, and want to protect the house-mates against it, both while it is active and after it is over, we no longer grope after some mysterous, intangible thing, before which we must bow down or burn something, as if it were some demon which we would exorcise. We say to ourselves, if we can at once destroy, by boiling it or burning it or soaking it in some suitable disinfectant, all the material which is discharged from the patient's body, he will cease to be a source of contagion—the poison cannot spread from

him. When the illness is over and we disinfect the rooms, we aim not to drive out any malign spirit, any mysterious kobold lingering in the air, but we are trying to kill the bacteria or other similar organisms which may have escaped our vigilance during the disease, and in more or less solid form or as floating dust have found lodgment on bedding, furniture, garments, or on walls or hangings. In all the management of the sick room, in all we do for the person of one suffering from an infectious disease, this is the conception which we should cherish as to the source of danger.

Most likely many will say, in view of what has been set forth in this little book about the transmission of the germ of consumption by floating dust: "Why do we not all catch consumption, if, as he says, it is contagious? We should be very apt to catch small-pox or scarlatina if brought in contact with them. It can't be true that consumption is contagious." To this it may be answered that some of these diseases are much more readily communicated than others are from person to person. Thus scarlet-fever and measles and small-pox are

much more readily transmitted than is diphtheria or consumption ; they are, as we say, more highly contagious, and although we do not yet exactly know what form of germ causes scarlet-fever and measles and small-pox, we are pretty certain that they are caused by germs or lowly organisms of some kind, and that these are much more readily or freely given off from the body than are the germs which cause less easily communicated diseases, such as consumption and diphtheria, and are more liable to exist in the form of particles which float in the air as impalpable dust.

Then, again, we should not lose sight of the fact that the germ of consumption is a very slowly-growing germ ; that only under a very limited range of conditions does it grow at all, and that after all the chances are not very great for each one of us that from aërial contaminations a sufficient number of the living bacilli, even if breathed in and passing all the safeguards of the body against such intruders, at last find lodgment in the tissues, will find the conditions favorable for a sufficient growth to induce the disease. Now and again only does

the favorable combination of conditions occur, but—and let this be noted well—the nows and agains are frequent enough in the aggregate to secure for consumption the distinction of being the most common and serious, as it is the most distinctly preventable, disease known to man.

It might be thought that if we know what form of germ causes a given infectious disease, and what chemical substance or drug will kill it, we could readily control the disease when once established in the body by giving a medicine which would kill the germs. So we could; but unfortunately the whole body is made up of little masses of living matter, which we call cells, and these are about as readily killed as bacteria are by the drugs which we should like to use for this purpose. So that in killing the germs we should be apt to stop the disease indeed, but kill the body too.

We hope sometime, as has been already said, to find some sort of agency which will kill, or render harmless, the germs which cause infectious diseases without harming the body. But in the meanwhile, and perhaps always—since the Irishman's conduct in swallowing

a potato-bug and then swallowing Paris green to kill it was not very rational—we must do the best we can along the lines which have been suggested in this book to prevent the occurrence of these diseases by destroying the germs before they get scattered in the dust, or, failing in the opportunity for this, see to it that the dust itself is intelligently disposed of.

One of the most serious obstacles in the way of clean living in towns in this country is the especially American expectoratory prerogative, which so frequently both anticipates and accompanies the franchise in otherwise decent males. The trick is early acquired by our mongrel immigrants, who lose no time in bettering our instructions. Could women, walking upon our streets, leaving cars, and descending from elevated railroad stations, but see themselves and their environment as others see them, the management of the skirts of walking-suits would, it would seem, command from them a more careful attention. We must speak plainly here, for very surely unto dust does all this expectorated unspeakableness soon return.

The spectacle of the well-dressed, filthy brutes, whom natural selection has most unkindly left but a few degrees higher than their congeners in the sty, wallowing in their expectoration, about certain hotels and theatre entrances, may well impress the sensitive onlooker with the colossal task which Nature undertook when she set to work to evolve man, and the lamentable failures which are so often but half-concealed in fashionable attire.

CHAPTER XII.

SUMMARY AND CONCLUSION.

IF, now, we sum up the main points which have been urged regarding the ordinary mode of transmission from one to another through the air of the germ of consumption and the means of avoiding it, we see, in the first place, that the most complete remedy of existing evils is simply the immediate destruction of the material discharged from the lungs of affected persons; second, the practice, both in private houses, in places of assembly, and in public conveyances, of more intelligent and efficient systems of cleaning, and particularly the adoption of appropriate means for getting rid of the floating or settled dust.

The dust of ordinarily clean public rooms and of private houses is not, as we have seen, dangerous or especially harmful unless it has

among its ingredients the living germs which have come from the bodies of persons suffering from bacterial disease. This dangerous admixture in dust is always possible in populous towns, and while the danger from this source is in general not very imminent, it is increased in direct proportion to the accumulation of dust which is allowed to occur either in private houses or places of assembly.

Two important means exist for getting rid of dust either in private houses or in places of assembly or public conveyances. The first is to sweep and to stir up the dust with windows and doors wide open, so that the temporarily floating particles may be largely carried out-of-doors, where they will be soon diluted and swept off. It should, in the second place, be borne in mind that in still rooms the dust, and with it the larger part of the aërial germs, will settle, within a few hours, so as to leave the room almost entirely free from them. If, now, the mopping of the floor or the dusting of furniture with moist cloths be practised, the larger part of the dust may be completely removed from the rooms. The completeness of this

removal will, of course, depend largely upon the simplicity of the furnishing and the intelligence which is used in the work. The relegation of the work of sweeping and dusting of rooms to ignorant and careless servants, without intelligent and persistent supervision, cannot be expected to result in clean living-places.

We realize more fully now than ever before, weighing the accumulated experience of years in the light of the new knowledge about the cause of consumption, that this disease is by no means always a hopeless or fatal one. Many persons get well, and many more so far recover as to enjoy years of comfortable life. We do not yet know any particular drug or any especial medical treatment which can be depended upon to cure consumption. But we do know that, by putting the body under certain favorable conditions—proper food, suitable climate, appropriate regimen, and aiding these, when occasion requires, by drugs,—the physician can often hold out to his patient this well-grounded hope, that the body's natural safeguards against the invasions of bacteria reinforced in this way may lead him to recovery and a new life. But

this lesson, first of all, the patient should learn, that he must see to it that all expectoration be destroyed, or else he is constantly running the risk of reinfecting himself, and thus destroying his chances of a victory over the disease, and is, moreover, exposing others to a serious risk of acquiring it.

The establishment of special sanitariums in the country where consumptives may be intelligently cared for is not only of great benefit to the stricken individuals themselves—giving them, as a rule, the best chances for recovery, —but is of incalculable importance to communities at large, since it removes an important and, as we have seen, often active source of dissemination of the disease.

It has not seemed to fall within the scope of this little book to give detailed directions as to the most efficient means of destroying infectious material in the sick room nor the modes of disinfection of such rooms when the disease has passed, because these are matters which will always be attended to by the physician if he be intelligent and well informed, and must vary more or less with the conditions of each case.

A little thoughtful consideration of the facts and principles which have been set forth cannot fail to result, under ordinary circumstances, in an improved sanitary condition of the places in which we so largely spend our lives.

We are just entering upon a new epoch in our knowledge of disease. The discovery of the bacterial origin of so many of the infectious diseases, which have hitherto been as mysterious as they were fatal, has placed us on a higher plane, so that there is a good hope that in the not distant future we may not only in large degree limit the spread of these diseases, but even learn some reliable means of cure for them. We have in our hands to-day as we have seen the means of prevention in large measure of consumption provided the simplest dictates of cleanliness be followed and the same may be said of typhoid-fever, diphtheria, erysipelas, blood-poisoning, and several other infectious diseases.

It is because medical science is raising itself, in the light of our new knowledge, to the higher plane of the general prevention of the infectious diseases, that we are hearing so much

nowadays about bacteria and germs and infection and the need of a more intelligent cleanliness.

It is not a mere fashion at whose dictates the doctrine of cleanliness in person, food, and air is being so widely and earnestly proclaimed to-day. It is no fad of the hour which is to pass and be forgotten. If our research into the sources of widespread human ill does carry us down into the realm of the invisible world we bring from it such knowledge as is full of significance and rich in the promise of human weal, if we do but heed the lessons which are already clear, precise, and not easily to be mistaken.

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THE END.